AL.2.1998-85
c.2

CANADIANA

SEP 23 1997

Forest Development Research

PROGRAM

Manning Diversified Forest Products Research Trust Fund
MDFP 7/96
New Herbicides For Calamagrostis Control
Final Report 1996/97

Alberta
ENVIRONMENTAL PROTECTION

Manning Diversified Forest Products Research Trust Fund

MDFP 7/96

New Herbicides For Calamagrostis Control

Final Report 1996/97

February 1997

By Deanna Koebernick
MDFP Ltd. Project Leader - Steve Blanton
Manning, Alberta
Canada

Pub. No. T/386
ISBN: 0-7732-9994-7

- Disclaimer -

The study on which this report is based was funded by the Manning Diversified Forest Products Research Trust Fund (MDFP) which is a component of Alberta's Environmental Protection and Enhancement Fund (EPEF). The views, statements and conclusions expressed, and the recommendations made in this report are entirely those of the author(s) and should not be construed as the statements conclusions, or opinions of members of the Manning Diversified Forest Products Research Trust Fund or of the Government of Alberta and its EPE Fund.

CONTROL OF *CALAMAGROSTIS CANADENSIS*

1996 FIELD RESEARCH SUMMARY

Deanna Koebernick

Introduction:

Calamagrostis canadensis (blue-joint reedgrass) is an invasive perennial rhizomatrous grass that establishes rapidly in forest cut blocks and competes with tree seedlings, limiting growth potential and seedling survival. The only chemical control currently available is glyphosate, applied in the fall when spruce and pine seedlings are dormant. A herbicide screen was conducted in the greenhouse in the winter of 1995 to determine efficacy of five herbicides for the control of young explants. Herbicides tested included clethodim (Select), glyphosate (Vision), fluazifop (Venture), fenoxaprop (Puma) and sethoxydim (Poast), all of which are registered for control of grass weeds in agricultural crops. Rates used were those recommended for control of *Agropyron repens* (quackgrass) in agricultural crops and 2 and 4 times the label rate. All rates of Vision, Poast and Select gave greater than 90% control of C. *canadensis;* these herbicides were selected to be tested under field conditions.

Materials and Methods:

Two research trials were established on cut blocks approximately 60 km north west of Whitecourt, Alberta. Trial 96CAL1 was located on Block 84 which had been cleared in the winter of 1994/1995. Trial 96CAL2 was located on block 85 which was logged in the summer of 1995. Treatments included Select and Poast at 0.5, 1 and 2 times the label rate, Vision at the label rate and an untreated check (Table 1). The trial was designed as a randomized complete block with 4 replicates. Herbicide applications were made on July 30, using a back pack sprayer. In both trials the C. *canadensis* was headed out. Visual evaluations (0% is no effect and 100% is complete kill) were conducted at 14, 28 and 62 days after application.

Summary and Conclusions:

In both trials, Vision at 2136 g a.i./ha gave 100% control of C. *canadensis* 62 days after application (Table 1). Treatments of Post and Select gave less than 40% control of C. *canadensis*. In 96CAL1, control of C. canadensis was not more than 25% 62 days after application. In 96CAL2, Select at 180 g a.i./ha and Poast at 1000 g a.i./ha gave 38% control of C. *canadensis*. Select at 180 g a.i./ha gave significantly (SNK, 10%) better control of C. *canadensis* than Select at 45 g a.i./ha. There was no significant difference between any other of the Poast and Select treatments.

Future Research:

These trials will be evaluated in the spring and summer of 1997, to evaluate regrowth. Two additional trials will be established adjacent to these trials, with herbicide applications to take place in the early spring soon after growth of C. *canadensis* has began. This will give comparative data for an early spring application versus a late summer application. An attempt will be made to locate another site, cleared in the summer of 1996 or winter of 1996/1997. This will provide efficacy information from newly established grass on a recently cleared area.

TABLE 1: PER CENT CONTROL OF *CALAMAGROSTIS CANADENSIS*

96CAL1	RATE g a.i./ha	14 DAA 13-Aug-96	28 DAA 27-Aug-96	62 DAA 27-Sep-96
Poast	250	18 b	23 b	23 b
Poast	500	18 b	30 b	25 b
Poast	1000	20 b	28 b	23 b
Select	45	14 b	20 b	25 b
Select	90	13 b	20 b	23 b
Select	180	14 b	30 b	25 b
Vision	2136	85 a	95 a	100 a

96CAL2	RATE g a.i./ha	14 DAA 13-Aug-96	28 DAA 27-Aug-96	62 DAA 27-Sep-96
Poast	250	20 b	23 b	33 b
Poast	500	18 b	30 bcd	28 bc
Poast	1000	20 b	30 bcd	38 b
Select	45	18 b	25 cd	20 c
Select	90	20 b	35 b	28 bc
Select	180	18 b	33 bc	38 b
Vision	2136	68 a	94 a	100 a

Means followed by the same letter do not significantly differ (P=0.10, SNK)

Herbicide Screen for *Calamagrostis canadensis* Control

L.M. Hall*, D. E. Koebernick*, R. Krieger°
*Agronomy Unit, Alberta Agriculture, Food & Rural Development
°Millar Western Industries

INTRODUCTION

DRAFT

Calamagrostis canadensis infestations can preclude successful white spruce seedling establishment in Northern Alberta (Con and Deck, 1991). *C. canadensis* occurs at low abundance in mature forest stands but this invasive perennial rhizomatous grass establishes rapidly in areas after a disturbance such as logging. It competes with *Picea glauca*, *Pinus contorta* and *Populus tremuloides* seedlings for limited resources. *C. canadensis* thatch can delay the thawing of soil in the spring by up to one month (Hogg and Lieffers, 1991), reducing productivity of tree species. Thatch under snow load may also form a physical barrier, detrimental to seedling survival. Because of its competitive nature, *C. canadensis* should be controlled before or soon after disturbance, before *C. canadensis* establishment and thatching. However, many hectares of previously disturbed or logged areas currently remain under or unstocked because of this grass.

To date, control strategies have focused on non selective herbicides (Con and Deck, 1991), and cultural, biological or mechanical control methods (Lieffers *et al*, 1993). Herbicide strategies include glyphosate applied as Vision® in the autumn when some crop trees are dormant. While glyphosate is effective in autumn, it is not an optimal time for control as the annual effects of competition and thatching have already occurred.

There are many selective grass herbicides currently registered for agricultural use on food crops. They are members of two chemical groups, the aryloxyphenoxyproprionate (AOPP) and cyclohexanediones (CHD). Herbicides in these two chemical families affect the same target site, the enzyme ACCase (E.C. 6.4.1.2). This is a key enzyme in the biosynthetic pathway of fatty acids. Grasses have an ACCase enzyme which is sensitive, while most broadleaves have an enzyme insensitive to these herbicides. Because of differences at the target site, these compounds have no effect on most broadleaves. These effective grass herbicides are foliar applied but have no residual control. Perennial weed control, therefore, depends on translocation of the herbicide and movement to distal roots and rhizomes. Additionally, the AOPP and CHD herbicides are not readily leached in soil, are broken down readily by soil microbes, are active in low doses and are not harmful to mammals.

Successful weed control integrates chemical, cultural, mechanical and biological control methods. Integrated weed management combines several control methods in a strategic approach designed to prevent weeds from becoming competitive with crop plants. It depends on prevention, rather than rescue; small scale intervention at appropriate times, rather than large scale, intrusive reactions.

The purpose of this experiment was to determine the usefulness of the AOPP and CHD herbicides as a possible component of an integrated weed management program. Selective grass herbicides are a potential tool for forest managers which could reduce *C. canadensis* infestations, leaving crop species and non target species like shrubs and forbs. During the winter of 1959/96 a greenhouse screen was conducted to identify AOPP and CHD herbicides effective on *C. canadensis* but non-toxic to crop tree species *P. glauca*, *P. contorta* and *P. tremuloides*.

DRAFT

MATERIALS AND METHODS:

Plant Materials. *Calamagrostis canadensis* rhizomes were obtained from the Whitecourt area of Alberta, washed and cut into sections, each containing a bud. Rhizome sections were planted into pots (four per pot) filled with Metro-mix and maintained in a greenhouse with temperatures of 21/18 °C day/night and 18/6 hours of light/dark period, respectively. Natural light was supplemented with 16 hours of HID lamps. Plants were watered as required and fertilized biweekly with 20-20-20 Complete. Pots of *C. canadensis* were sorted so that each treatment contained a total of sixteen plants. *P.*

tremuloides, *P. glauca* and *P. contorta* seedlings were obtained from Millar Western Industries and placed into storage at -3°C. After 52 days, seedlings were planted into pots (two seedlings per pot) filled with Metro-mix and maintained in a greenhouse under the conditions previously stated. *P. tremuloides* seedlings were allowed to leaf out (65 days), then were sorted into replicates by size. The treatments were replicated three times with the exception of *P. tremuloides* which was only replicated twice due to a shortage of seedlings. The pots were sorted so that each treatment consisted of a total of eight seedlings.

Herbicide Application. Herbicide applications were made to *C. canadensis* when a majority of the plants had reached 20 cm in height. Crop trees were sprayed during a time when they were expected to be most sensitive to herbicide damage, after bud break, during rapid growth. Applications were made to *P. glauca* and *P. contorta* when seedlings were 10-40 cm tall. *P. tremuloides* were sprayed when the seedlings were 15-40 cm tall. Herbicide applications were conducted in an automated spray chamber equipped with a 8001 EVS nozzle at 300 kPa at 2.10 km hr^{-1} delivering 100 L ha^{-1} of spray solution. The herbicides evaluated were quizalofop-ethyl at 142.8, 284.16 and 568.32 g a.i./ha^{-1}, sethoxydim at 494.96, 989.92 and 1979.84 g a.i./ha^{-1}, fenoxaprop-p-ethyl at 92, 184 and 368 g a.i./ha^{-1}, clethodim at 91.2, 182.4 and 364.8 g a.i./ha^{-1}, fluazifop-p-butyl at 172.9, 345.8 and 2766.4 g a.i./ha^{-1} and glyphosate at 2136 g a.i./ha^{-1} (Table 1). Rates were chosen based on the recommended rate for control of *Agropyron repens*, plus two and four times this rate. Adjuvants were used according to the recommended rate. Plants were evaluated at 1, 2, 4 and 6 weeks after treatment. Visual percent control and percent injury ratings were conducted by comparing the treated plants to the untreated control and Canplus 411 alone; where 0% indicates no visible effects and 100% indicates complete control. Following the 6 week rating, above ground biomass of *C. canadensis* plants were harvested, dried in ovens for 48 hours at 60°C, then weighed to determine total dry matter. Fenoxaprop-p-ethyl gave poor control of *C. canadensis* and was consequently eliminated from the tolerance screen.

Statistical Design. The experimental design was a randomized complete block. Means were separated by Duncan's Multiple Range Test at the 0.05 probability level.

DRAFT

RESULTS AND DISCUSSION:

Sethoxydim and clethodim provided greater than 90% control of *C. canadensis* six weeks after application at the lowest rate and were comparable to glyphosate (Table 2, Figure 1). Quizalofop-ethyl control of *C. canadensis* increased with herbicide rate, from 63 , 75 and 92 % respectively. Fluazifop-p-ethyl was less effective, with only 72% control at the highest rate. Fenoxaprop was not effective at controlling *C. canadensis* and was dropped from subsequent experiments. Plants treated with Canplus 411 alone did not differ from the untreated controls. All of the herbicides decreased above ground dry weight accumulations, as compared to controls, however the six week interval between spraying and harvesting did not allow sufficient re-growth to differentiate between herbicide treatments (Figure 2).

Quizalofop-ethyl, sethoxydim, clethodim and fluazifop-p-butyl showed less that 5% damage at the highest rates compared to the control plants. *P. glauca* seedlings were sensitive to glyphosate, with 30% damage (Figure 3). *P. contorta* showed 37% damage from glyphosate, and less that 10% damage from all other herbicide treatments (Figure 4).

Injury by the AOPP and CHD herbicides generally increased with herbicide rate (Figure 5). Clethodim was most injurious, with 35, 45 and 45% damage at the 1, 2 and 4 times rate, respectively. Sethoxydim caused 5, 15 and 25% injury, respectively. Tolerance information on *P. tremuloides* is less complete than for *P glauca* and *P. contorta* because of the loss of a replicate. Glyphosate was very injurious to *P. tremuloides* seedlings with 100% injury.

The herbicides sethoxydim, clethodim and quizalofop-ethyl show promise as selective herbicides for *C. canadensis* control. All are non-injurious to *P. glauca* and *P. contorta*. Quizalofop shows the least injury to *P. tremuloides*, sethoxydim is more injurious and clethodim most injurious to *P. tremuloides* under greenhouse conditions.

DRAFT

While this greenhouse screen has identified candidate herbicides which control *C. canadensis*, results must be confirmed by trials performed in the field. Several factors, including herbicide rate for effective *C. canadensis* control in the first and second year after application, crop tree injury during various times of the year, and the response of crop trees to removal of *C. canadensis* will need to be established under field conditions.

The optimum time during the forest renewal cycle for herbicide intervention also needs to be determined. *C. canadensis* establishment and invasion occurs within a larger cycle of forest renewal. The forest renewal cycle and silviculture practices pre-harvest, post-harvest, site preparation and seedling establishment dramatically affect presence of *C. canadensis* seeds and rhizomes for innoculum and their successful establishment. When *C. canadensis* establishment biology is combined with understanding of the renewal cycle and control measures, more effective intervention may be possible

DRAFT

LITERATURE CITED

1 Blackmore, D. G. and W. G. Corns. 1979. Lodgepole pine and white spruce establishment after glyphosate and fertilizer treatments of grass cutover forest land. Forestry Chronicle 55:102-105.

2. Conn, J. S. and R. E. Deck. 1991. Bluejoint reedgrass (*Calamagrostis canadensis*) control with glyphosate and additives. Weed Tech. 5:521-524

3. Hogg, E. H. and V. J. Lieffers. 1990. The relationship between seasonal changes in rhizome carbohydrate reserves and recovery following disturbance in *Calamagrostis canadensis*. Can. J. Bot. 69:641-646.

4. Conn, J. S., C. L. Cochrane, and J. A. DeLapp. 1984. Soil seed bank changes after forest clearing and agricultural use in Alaska. Weed Sci. 32:343-347.

5. Hogg, E. H. and V. J. Lieffers. 1991. The impact of *Calamagrostis canadensis* on soil thermal regimes after logging in northern Alberta. Can. J. For. Res. 21:387-394.

6. Hogg, E. H. and V. J. Lieffers. 1990. Seasonal changes in shoot regrowth potential in *Calmagrostis canadensis*. Oecologia 95:596-602.

7. Lieffers, V. J., S. E. MacDonald, and E.H. Hogg. 1993. Ecology of control strategies for *Calamagrostis canadensis* in borel forest sites. Can. J. For. Res. 23:2070-2077.

8. McDonald, P. M.. 1986. Grasses in young conifer plantations - hindrance and help. 1986. Nortwest Sci. 60:17`-278.

9. MacDonald, S. E. and V. J. Lieffers. 1993. Rhizome plasticity and clonal foraging of *Calamagrostis canadensis* in response to habitat heterogeneity. J. of Eco. 81:769-776.

10. MacDonald, S. E. and V. J. Lieffers. 1991. Population variation, outcrossing, and colonization of disturbed areas by *Calamagrostis canadensis*: evidence from allozyme analysis. Am. J. of Bot. 78:1123-1129.

11. Powelson, R. A. and V. J. Lieffers. 1992. Effect of light and nutrients on biomass allocation in *Calmagrotis canadensis.* Ecography 15:31-36.

DRAFT

Table 2: Control of *Calamagrostis canadensis* and Tolerance of *Populus tremuloides*, *Picea glauca* and *Pinus contorta* 6 Weeks After Treatment

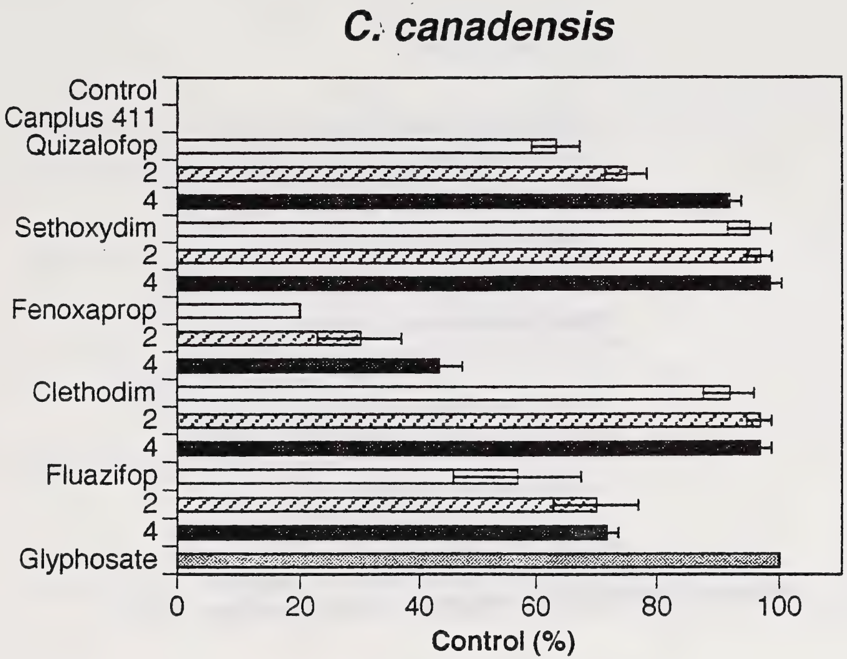
HERBICIDE COMMON	HERBICIDE ACTIVE	RATE g a.i. ha^{-1}	RATE L ha^{-1} g ha^{-1}	ADJUVANT	RATE ADJUVANT % v/v	AVERAGE % CONTROL *C. canadensis*	AVERAGE DRY WEIGHT g	AVERAGE % INJURY *P. glauca*	AVERAGE % INJURY *P. contorta*	AVERAGE % INJURY *P. tremuloides*
Control						0g*	15.67ab	0b	0b	0f
Canplus 411					0.5	0g	15.28ab	0b	0b	0f
Assure	quizalofop-ethyl	142.08	1.48	Canplus 411	0.5	63.3cd	7.5d	0b	0b	5ef
Assure	quizalofop-ethyl	284.16	2.96	Canplus 411	0.5	75b	7.43d	0b	0b	0f
Assure	quizalofop-ethyl	568.32	5.92	Canplus 411	0.5	91.7a	10.85cd	3.33b	0b	15def
Poast	sethoxydim	494.96	2.69	Merge	1	95a	11.07cd	0b	3.33b	5ef
Poast	sethoxydim	989.92	5.38	Merge	1	96.7a	10.83cd	0b	0b	15def
Poast	sethoxydim	1979.84	10.76	Merge	1	98.3a	10.92cd	1.67b	6.67b	25cd
Puma	fenoxaprop-p-ethyl	92	1			20f	13.04abc			
Puma	fenoxaprop-p-ethyl	184	2			30f	12.03bc			
Puma	fenoxaprop-p-ethyl	368	4			43.3e	11.25cd			
Select	clethodim	91.2	0.38	Amigo	1	91.7a	11.13cd	0b	0b	35bc
Select	clethodim	182.4	0.76	Amigo	1	96.7a	11.23 cd	0b	0b	45b
Select	clethodim	364.8	1.52	Amigo	1	96.7a	11.14cd	3.33b	0b	45b
Venture	fluazifop-p-butyl	172.9	691.6	Charge	1	56.7d	11.09cd	1.67b	6.67b	10def
Venture	fluazifop-p-butyl	345.8	1383	Charge	1	70bc	11.15cd	0b	0	10def
Venture	fluazifop-p-butyl	691.6	2766	Charge	1	71.7bc	10.87cd	0b	3.33b	20cde
Vision	glyphosate	2136	6			100a	10.75cd	30a	36.67a	100a

* Duncan's Multiple Range at the 0.05 probability level

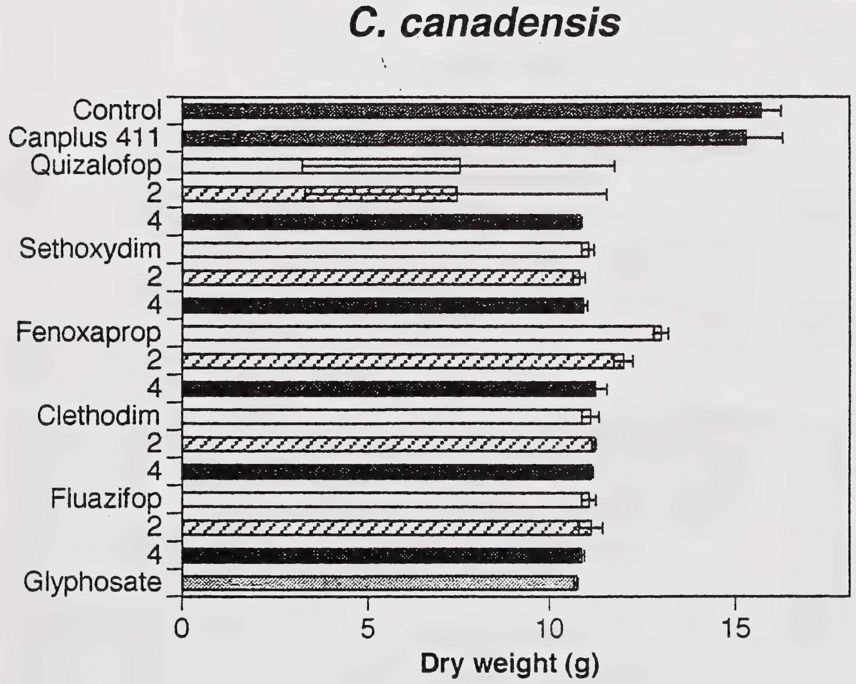
Table 1: Herbicide Treatments

HERBICIDE COMMON NAME	HERBICIDE ACTIVE	RATE g a.i. ha^{-1}	RATE L ha^{-1} g ha^{-1}	ADJUVANT	RATE ADJUVANT % v/v
Control					
Canplus 411					0.5
Assure	quizalofop-ethyl	142.08	1.48	Canplus 411	0.5
Assure	quizalofop-ethyl	284.16	2.96	Canplus 411	0.5
Assure	quizalofop-ethyl	568.32	5.92	Canplus 411	0.5
Poast	sethoxydim	494.96	2.69	Merge	1
Poast	sethoxydim	989.92	5.38	Merge	1
Poast	sethoxydim	1979.84	10.76	Merge	1
Puma	fenoxaprop-p-ethyl	92	1		
Puma	fenoxaprop-p-ethyl	184	2		
Puma	fenoxaprop-p-ethyl	368	4		
Select	clethodim	91.2	0.38	Amigo	1
Select	clethodim	182.4	0.76	Amigo	1
Select	clethodim	364.8	1.52	Amigo	1
Venture	fluazifop-p-butyl	172.9	691.6	Charge	1
Venture	fluazifop-p-butyl	345.8	1383.2	Charge	1
Venture	fluazifop-p-butyl	691.6	2766.4	Charge	1
Vision	glyphosate	2136	6		

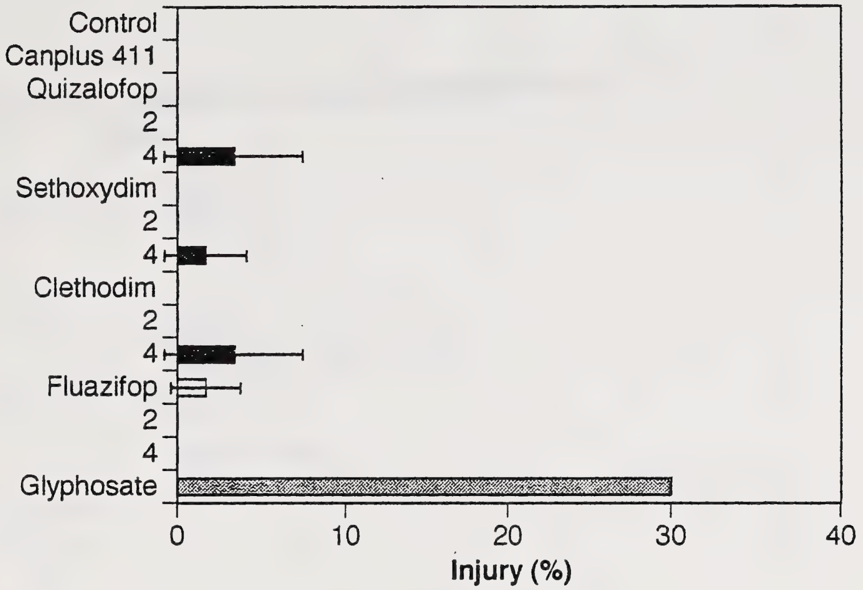
DRAFT


C. canadensis
Control
Canplus 411
Quizalofop
2
4
Sethoxydim
2
4
Fenoxaprop
2
4
Clethodim
2
4
Fluazifop
2
4
Glyphosate
0
20
40
60
80
100
Control (%)

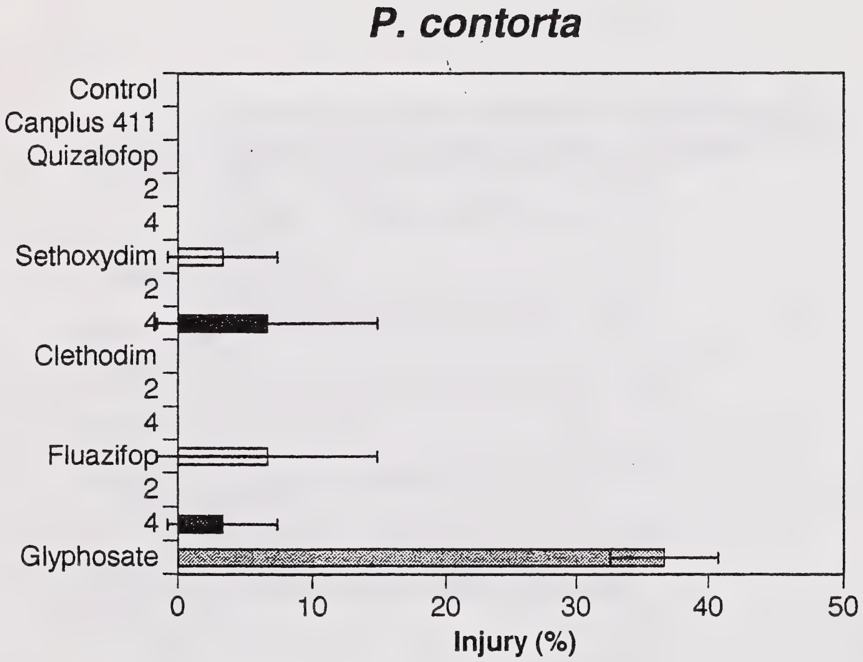
DRAFT


C. canadensis

DRAFT

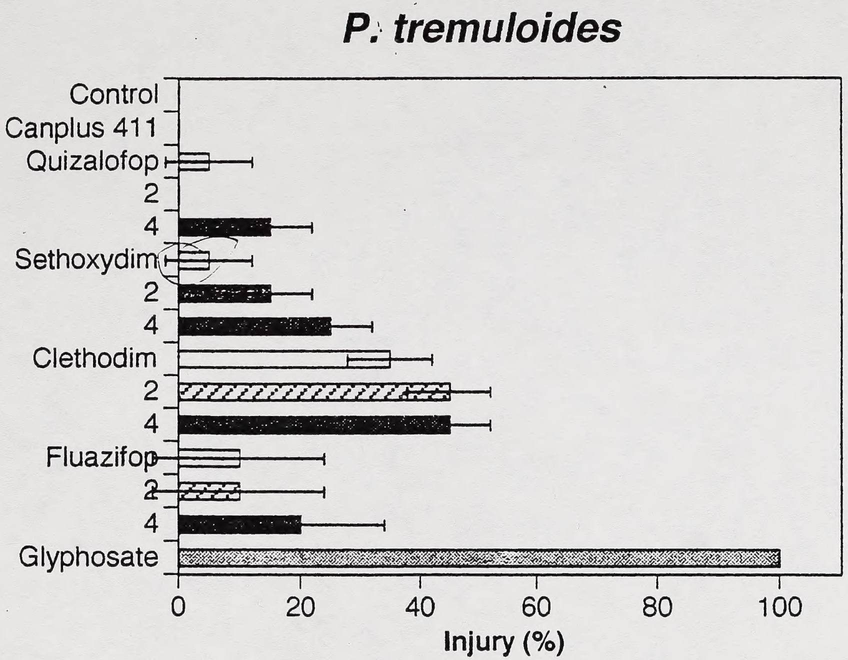

P. glauca

DRAFT



P. contorta

DRAFT



P. tremuloides

DRAFT

National Library of Canada
Bibliothèque nationale du Canada
3 3286 51357 0396